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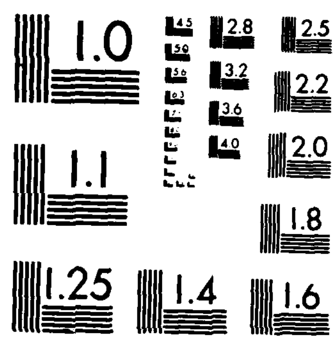

MICROCOPY RESOLUTION TEST CHART
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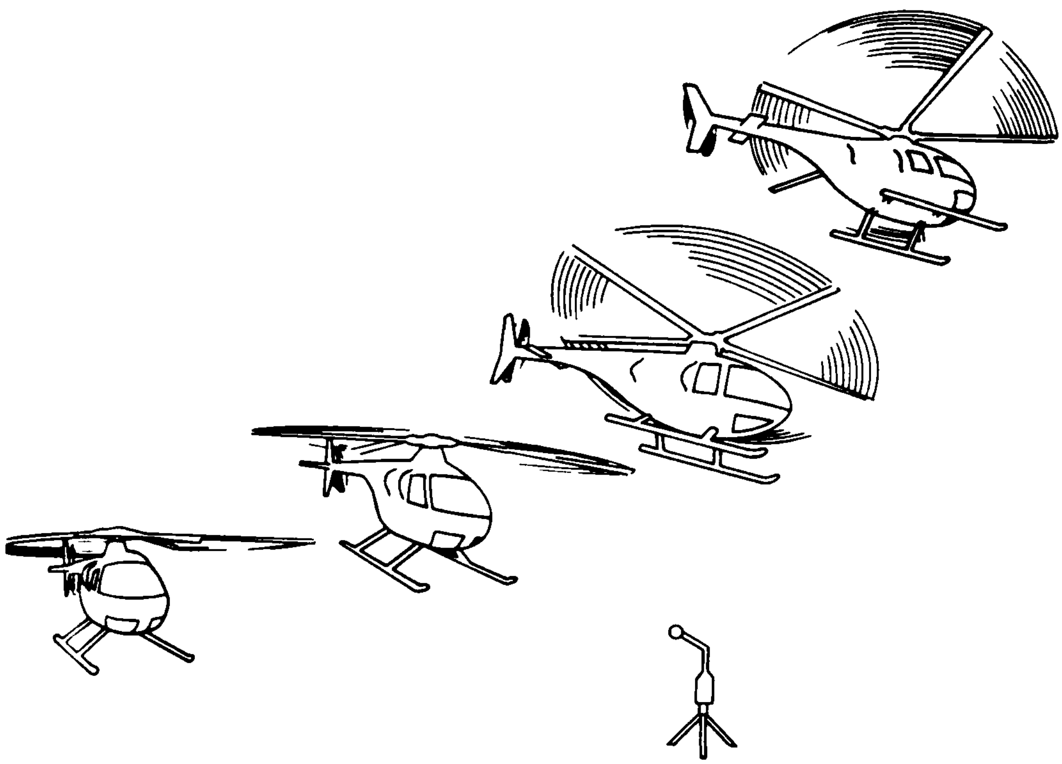
U.S. Department of Transportation
Federal Aviation Administration

June 1986

Report No.

FAA-EE-86-04

NOISE LEVELS FROM URBAN HELICOPTER OPERATIONS NEW ORLEANS, LOUISIANA



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16. Abstract

The FAA conducted a noise monitoring program of helicopter operations at the Lakefront Airport in New Orleans, Louisiana. The purpose was to obtain noise measurements from helicopter operations in an urban environment. During this monitoring program the FAA concentrated solely on helicopter approaches to Lakefront Airport. The noise data collected and classified as survey type data, since the manitoring program's measurements data obtained were from "target of opportunity" as opposed to a "controlled test" when the helicopter follow predefined flight path profiles. During the testing period, there were ten different helicopter models. Because of the high frequency of operations an opportunity was provided to determine the consistency between ALM values for the same helicopter model for different events. Since some of the monitoring sites were located in a residential community, an opportunity was provided to gather information on noise levels associated with a high frequency of helicopter operations.

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1.0 Introduction

During the period of January 14-18, 1985, the FAA conducted a noise monitoring program of helicopter operations at the Lakefront Airport in New Orleans, Louisiana. This is a companion report to a previous report which analyzed noise levels from helicopter operations in Las Vegas (Helicopter Noise Survey Performed at Las Vegas, Nevada FAA-EE-84-15). As in the previous analysis, the purpose was to obtain noise measurements from helicopter operations in an urban environment. The Las Vegas noise monitoring program conducted in 1984, foscused primarily on helicopter takeoffs. In this program, the FAA concentrated solely on the approaches. In addition, this field measurement program afforded the FAA the opportunity to conduct a noise monitoring program in a residential area near concentrated helicopter operations.

The noise data collected are classified as survey type data, since the monitoring program's measurements data obtained were from "targets of opportunity" as opposed to a "controlled test" where the helicopters follow predefined flight path profiles. The helicopter flight corridors into and out of the departure and landing sites were prescribed by the airport operator to separate the helicopter operations from the fixed wing aircraft. However, there were no limitations placed on the helicopter pilots to control individual flight paths, rate of climb, rate of descent, airspeed, operational weight, etc. As such, the landings and takeoffs represent operations into and out of this particular site for the particular test day meteorological conditions.

During the testing period, there were ten different helicopter models monitored. Because of the high frequency of operations (i.e an average of 15-20 per hr) the opportunity was provided to determine the consistency between maximum A-weighted sound level (ALm) values for the same helicopter model for different events, with variations in operations due to change in speed, glide slope, load, climb angle, pilot techniques, etc. within the prescribed flight corridor. This test also obtained sideline measurements of helicopter noise beyond 500 ft. The sites were located in established residential areas. This provided an opportunity to compare real time noise levels associated with a high frequency of helicopter operations in a nearby community. This report also contains noise measurements of helicopter models which are not in data bases previously reported by the FAA, notably the Bell 412 and Westland WG-30.

2.0 Noise Measurement Program

The FAA with support from Bell Helicopter Textron and Sikorsky Aircraft, conducted the noise measurement program. The test plan, developed and implemented by the FAA, laid out the conceptual approach for locating the monitoring sites and the objectives to be achieved. Industry participation consisted of providing coordination with helicopter traffic control and noise measurement crews who worked under the guidance of the FAA and supplemented the FAA's measurement crew. With industry's assistance it was possible to deploy two noise monitoring stations in the residential area adjacent to Lakefront Airport.

The noise data collected were from helicopters during their final approach into Lakefront Airport. An array of microphones were set out to measure noise from the helicopters in the approach flight corridor. One microphone was located beneath the approach path while the other three were located to the left and normal to the approach path of the helicopters.

3.0 Site Description

Lakefront Airport is located approximately 5 miles northeast of downtown New Orleans on the southern edge of Lake Pontchartrain. The area is relatively flat with winds predominately from the northwest during the winter season. Lakefront Airport is principally a general aviation airport with 221,264 operations during 1984. Figure 1 shows the layout of the airport. The HAI flight line was located on the southeast corner of the airport occupying runways 31 and taxiway Echo. The Lakefront control tower controlled both the helicopter traffic for the HAI Convention and the general aviation activity at the airport.

South of the airport is a levee which is approximately 20 ft in height. The levee is part of the flood protection system which protects the City of New Orleans from Lake Pontchartrain. The levee at this location also serves as a railroad right-of-way with the tracks on top of the levee. Beyond the levee south of the airport is a residential community of single family detached homes. This area has been designated as a noise sensitive area by the airport operator. Aircraft operating at Lakefront are instructed to avoid flying directly over this area when feasible. The

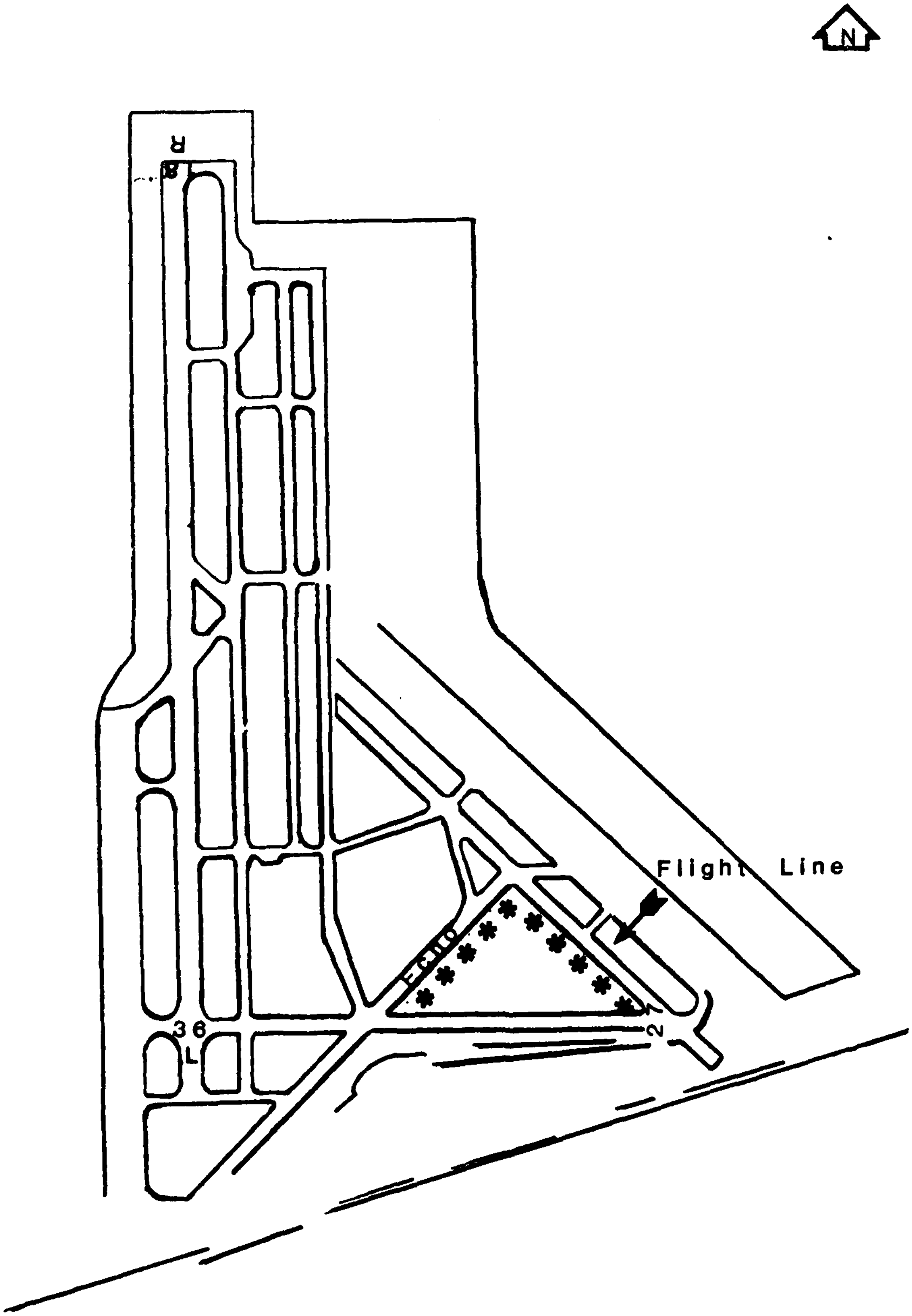

Figure 1 Lakefront Airport
New Orleans

helicopters approached the airport from the east by following Haynes boulevard which runs parallel to the noise sensitive area. Since the airport has received several noise complaints from residents in this area from aircraft flying over their neighborhood, the FAA was afforded the opportunity to measure noise in the community from the helicopters during approach to the airport while gathering information with respect to any noise complaints attributed to the helicopter fly-bys during approach.

4.0 Microphone Deployment

Figure 2 shows the respective locations of the noise monitoring stations. Site 1 which was designated the centerline center microphone was located at a distance of approximately 790 ft from the designated landing zone. Site 2 was located 325 ft; site 3, 1455 ft; and site 4, 2410 ft to the southwest of the centerline microphone. All of the sites were located on a grassy surface. Site 2 was situated on the airport grounds approximately 30 ft from the railroad right-of-way. The railroad right-of-way was used infrequently during the measurement program and therefore did not result in any loss of data due to noise interference. Sites 3 and 4 were located in a residential area to obtain measurements of the helicopters in relation to existing ambient conditions. Between sites 2 and 3 adjacent to the levee there is a four lane highway. Traffic volume during the testing was relatively light with the majority of the vehicles consisting of automobiles. The only physical barriers in the line of sight between monitoring sites 3 and 4 and the landing zone are one story houses and the 20 ft levee. These barriers created some shielding during the near-hover operation over the landing area and during

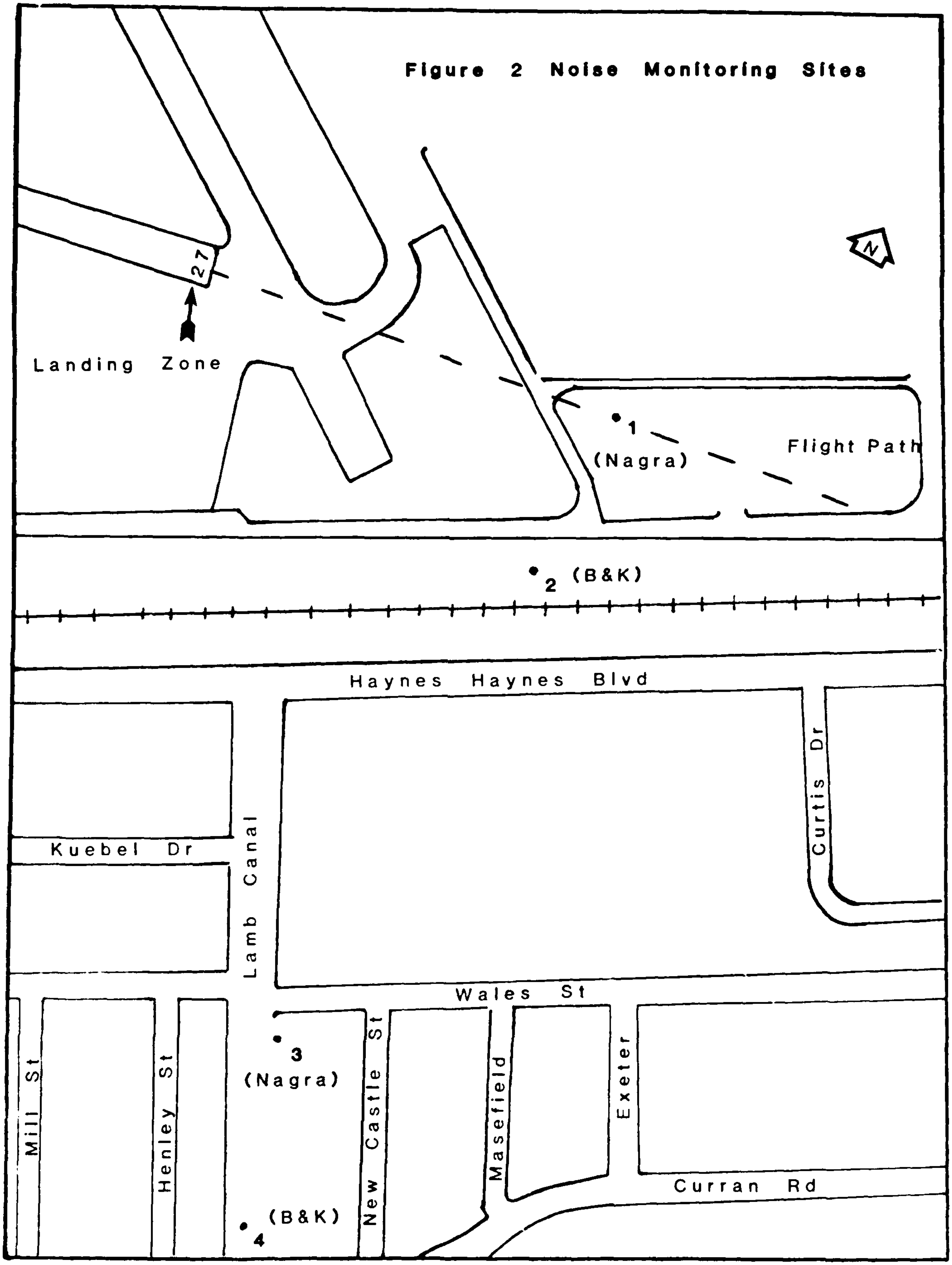
Figure 2 Noise Monitoring Sites
N
27
Landing Zone
1
(Nagra)
Flight Path
2 (B&K)
Haynes Haynes Blvd
Curtis Dr
Kuebel Dr
Lamb Canal
Wales St
3
(Nagra)
Mill St
Henley St
New Castle St
Masefield
Exeter
Curran Rd
4 (B&K)

air taxiing to the landing spot.

5.0 Flight Operations

The flight line for the HAI Convention was located at Lakefront Airport. The helicopters departed from mid-field toward the north over Lake Pontchartrain turning to the east heading to the deomonstration area. On returning to Lakefront Airport, when the helicopters were within approximately 2 miles of the airport, the pilots were instructed to fly parallel to Haynes Boulevard during their final approach to the numbers at the end of runway "27". The helicopters slowed to a near-hover over the designated landing zone "27". Then they air taxied to their designated landing spot.

6.0 Meteorological Conditions

Weather conditions were quite suitable for noise monitoring during the measurement program, that is, the skies were clear and the winds were light. A self-contained onsite meteorological system was deployed near the centerline microphone to monitor real-time temperature, wind speed, and wind direction. The surface temperature as measured from this system ranged from 40° to 50°F during the the three-day monitoring program. The winds were principally from the west, northwest, or north at an average speed of 7 mph. On a few occasions, the wind direction swung around to the southwest. Meteorological conditions during the test period did not affect the standard landing operations of the helicopters.

7.0 Instrumentation

7.1 Noise Monitoring Equipment

The following equipment was used at different times during the noise monitoring program, B&K Model 2233 and Model 4165 Precision Integrating Sound Level Meter (PISLM), Gen Rad 1945 Community Noise Analyzer, and NAGRA IVSJ magnetic tape recorder. A Nagra and B&K 2233 PISLM were located at site 1, a B&K 2218 PISLM was used at site 2, another Nagra and the Gen Rad 1945 were deployed at site 3 and a B&K 4165 was used at site 4.

The B&K systems used a 1/2 inch condenser microphone. The system is self-contained in that the microphone was directly attached to the PISLM. Output was observed on an analog scale and digital read out on the PISLM. The Gen Rad 1945 used a P-42 microphone-preamplifier driving a Gen Rad 1/2 inch electret microphone. The microphone preamplifier assembly was mounted on a tripod four (4) ft above ground level with the diaphragm oriented for grazing incidence.

At the end of each event, the observers noted the digital read out of the ALm (Maximum A-weighted Sound Level); Leq (Equivalent sound level); SEL (Sound Exposure Level); and the duration of the event. Measurements made with the Gen Rad 1945 were digitally outputed on an LED screen and at the end of the sampling period, the Leq values were annotated on the chart paper. The observers were located 20-30 ft from the microphone to avoid any shielding or interference.

The NAGRA IVSJ recorder analog signal was amplified to a suitable recording level and was recorded on channel one. A time code was recorded on the queue channel for traceability of events. The queue channel was also used by the observer to annotate the tape orally. The magnetic tapes recorded by the FAA were later reduced and analyzed at the FAA Noise Lab at Dulles International Airport. The magnetic tapes recorded by Bell and Sikorsky were reduced and analyzed at the Bell Helicopter Textron Acoustic Lab.

7.2 Photographic Scaling

Centerline altitude for the helicopters were determined according to SAE Aerospace Information Report 902. Each helicopter was photographed as it passed over the centerline center microphone position. The image in each photo was then scaled to the dimensions of the helicopter to determine the altitude of the helicopter at that point in its approach. Even though the helicopters did not always pass directly over the centerline position, an error of 27 degrees in the angle between the line of sight and the normal to the flight path would only result in a 1 dB SPL.

8.0 Discussion of the Data

8.1 Sample Size

During the three day monitoring program, there were 108 approach events. The data recovery (Table 1) for each site based on ALm readings is as

Table 1

Data Recovery for the New Orleans
Helicopter Noise Monitoring Program
at Lakefront Airport
(Percent)

Site (Distance from Centerline, ft)	Percent Recovered ALm Values	Percent Recovered SEL Values	Percent Recovered For Those Events That Passed Over Centerline ALm	Percent Recovered For Those Events That Passed Over Centerline SEL
1 (0)	87	69	100	79
2 (354)	73	43	77	40
3 (1455)	67	21	73	7
4 (2410)	46	0	52	0

follows: Site 1, 87%; Site 2, 73%; Site 3, 67%; and Site 4, 46%. Sites 1 and 2 had the highest percentage of valid readings. These sites had the least amount of noise interference. The loss of data at sites 1 and 2 was the result of interference due to routine vehicular and aircraft ground activity in the vicinity of the noise monitoring sites. The lower data recovery at sites 3 and 4 was due primarily to the relatively low signal-to-noise ratio and interference from community activity (i.e. automobiles, children playing, fly-bys from the airport, etc).

The data recovery based on SEL values is significantly lower than the ALm values especially for sites 3 & 4 which were located off the airport grounds. In order to have a valid SEL, the noise from the helicopter has to be 10 dBA higher then the existing ambient. Site 3 located at a distance of 1455 ft had a SEL data recovery of 7% while Site 4 recorded no valid SEL readings at a distance of 2410 ft. The nearness of sites 1 and 2 to the approach flight corridor enabled these sites to have a much higher data recovery than the two farther sideline sites. However, even site 2 lost a considerable amount of data at an average slant range distance of 375 ft from the glide slope. Loss of valid SEL readings at the two close-in sites is attributed to noise interference.

At the farther distances from the source of noise, it is hard to identify clearly the helicopter noise from other sources of noise. It is extremely difficult to record valid SEL readings at distant points from a noise generator. In actuality the helicopter noise is not lost data, but is part of the ambient. Very few events were lost due to equipment malfunction. The first five events were disregarded as they were used to

determine the range settings for the equipment.

Since the noise measurements were targets of opportunity, the helicopters did not necessarily always pass directly over the centerline microphone. In the evaluation process, events were screened to delete those outside certain criteria (i.e. when helicopters during their final approach to the designated landing zone did not pass over the centerline microphone). Of all the approach events recorded, 48 passed over the centerline microphone. It is these events which were considered for further evaluation and analysis in section 8.2. The data recovery for these 48 events is as follows: site 1, 100%; site 2, 77%; site 3, 73%; and site 4, 52%. The remaining helicopter approaches were too far left or right of the centerline microphone to be considered for any further analysis.

8.2 Evaluation of the Data

Table 2 presents the recorded ALm readings as measured for the centerline and sideline sites for those events where the helicopter passed directly over the centerline microphone. In addition, the sideline elevation angles, and the absolute decrease in dBA between the centerline reading and sideline sites are presented. The ALm values as recorded at the centerline microphone from all the helicopters ranged from 80.8 to 96.4 dBA. The highest recorded noise level of 96.4 dBA at the centerline microphone was associated with the Westland WG-30, which passed by at an altitude of 152 ft. The lowest reading was 80.8 dBA associated with the A-Star which flew by at an altitude of 231 ft. The average ALm readings for each helicopter type at the centerline microphone ranged from 85 to 91 dBA.

Table 2
HELICOPTER NOISE MEASUREMENTS FOR NEW OR[illegible]AN[illegible] A[illegible] 2[illegible] 1985

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft) 2	3	4	ALm (dBA) for Each Site 1	2	3	4
18.63	500-E	134	352	1461	2414	88.6	74.7	NA	NA
18.70	500-E	120	346	1460	2413	87.9	NA	60.0	57.0
18.72	500-E	170	367	1465	2416	87.8	NA	66.0	57.0
18.27	500-E	96	339	1458	2412	87.4	75.0	61.0	62.0
18.55	500-E	171	367	1465	2416	86.5	77.3	NA	NA
18.66	500-E	185	374	1467	2417	86.0	NA	62.0	61.0
18.61	500-E	195	379	1468	2418	85.0	NA	NA	NA
18.36	500-E	269	422	1480	2425	84.6	76.6	NA	62.0
18.58	500-E	184	373	1467	2417	83.4	73.8	63.5	NA
19.08	500-E	240	404	1475	2422	83.0	75.7	NA	NA
19.05	530-F	166	365	1464	2416	87.9	77.3	64.6	NA
18.46	530-F	141	354	1462	2414	87.3	76.2	NA	62.0
18.23	530-F	159	362	1464	2415	87.1	77.5	NA	NA
19.15	530-F	211	387	1470	2419	85.3	83.9	64.0	NA
18.11	530-F	169	366	1465	2416	84.2	75.1	NA	62.0
18.67	530-F	283	431	1482	2427	83.3	NA	66.0	NA
18.74	530-F	257	414	1478	2424	83.0	NA	66.3	NA
18.03	ASTAR	152	359	1463	2415	88.4	81.8	66.0	61.0
18.68	ASTAR	167	365	1465	2416	87.9	NA	62.0	NA
18.56	ASTAR	162	363	1464	2415	84.7	83.1	65.0	NA
19.04	ASTAR	151	358	1463	2415	84.0	79.7	65.0	NA
18.06	ASTAR	231	399	1473	2421	80.8	80.0	NA	72.0
18.62	B-206L3	124	348	1460	2413	87.9	78.4	NA	NA
18.21	B-206L3	143	355	1462	2414	84.8	76.4	NA	68.0
18.69	B-206L3	160	362	1464	2415	84.1	NA	70.0	NA
18.64	B-214	151	358	1463	2415	91.0	79.6	66.5	NA
18.44	B-214	172	368	1465	2416	88.5	79.8	64.0	NA
17.18	B-222UT	163	364	1464	2416	87.9	80.5	NA	68.0
18.52	B-222UT	146	356	1462	2414	87.1	78.9	NA	NA
17.09	B-222UT	163	364	1464	2416	87.0	80.6	66.0	63.0
19.09	B-222UT	219	392	1471	2420	84.6	76.4	67.0	NA
18.53	B-412	132	351	1461	2414	94.0	81.3	67.8	59.0
19.21	B-412	161	363	1464	2415	90.3	80.0	65.0	NA
18.08	B-412	295	439	1485	2428	88.8	83.2	73.0	NA
18.16	B-412	290	436	1484	2427	86.2	80.1	71.0	70.0
18.45	Dauphin	173	368	1465	2416	94.2	88.1	71.0	67.0
18.54	Dauphin	188	375	1467	2417	92.6	86.0	66.5	63.0
18.35	Dauphin	128	349	1461	2413	90.6	82.3	61.0	62.0
18.01	Dauphin	164	364	1464	2416	87.6	82.1	68.0	63.0
18.31	Dauphin	185	374	1467	2417	87.5	85.0	64.5	NA

Table 2
HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS, JANUARY 17-20, 1985

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft)			ALm (dBA) for Each Site			
			2	3	4	1	2	3	4
18.71	Dauphin	219	392	1471	2420	86.3	NA	70.5	63.0
18.49	Twin Star	181	372	1466	2417	88.5	82.8	70.0	62.0
17.08	Twin Star	202	383	1469	2418	87.0	83.0	69.0	64.0
18.65	Twin Star	220	392	1472	2420	86.0	NA	61.5	62.0
18.24	Twin Star	191	377	1467	2418	85.5	84.8	69.0	65.0
19.03	Twin Star	168	366	1465	2416	84.8	82.9	67.1	NA
18.29	WG-30	152	359	1463	2415	96.4	86.0	69.7	69.0
18.73	WG-30	250	410	1476	2423	85.6	NA	76.6	68.0

Table 2 (Continued)
HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS, JANUARY 17-20, 1985

Event Number	Helicopter	SEL (dBA) for Each Site			Elevation Angle for Each Site			Difference between Centerline & Sideline ALm in dB(A)		
		1	2	3	2	3	4	1-2	1-3	1-4
18.63	500-E	93.8	83.8		22.4	5.3	3.2	13.90	NA	NA
18.70	500-E	92.4			20.3	4.7	2.9	NA	27.90	30.90
18.72	500-E	94.9			27.6	6.7	4.0	NA	21.80	30.80
18.27	500-E				16.5	3.8	2.3	12.40	26.40	25.40
18.55	500-E	91.7			27.8	6.7	4.1	9.20	NA	NA
18.66	500-E				29.6	7.2	4.4	NA	24.00	25.00
18.61	500-E	91.0			31.0	7.6	4.6	NA	NA	NA
18.36	500-E	90.0			39.6	10.5	6.4	8.00	NA	22.60
18.58	500-E	92.0			29.5	7.2	4.4	9.60	19.90	NA
19.08	500-E	90.0			36.4	9.4	5.7	7.30	NA	NA
19.05	530-F	92.5		76.2	27.1	6.5	3.9	10.60	23.30	NA
18.46	530-F	93.2			23.5	5.5	3.3	11.10	NA	25.30
18.23	530-F				26.1	6.2	3.8	9.60	NA	NA
19.15	530-F	90.7	83.6		33.0	8.3	5.0	1.40	21.30	NA
18.11	530-F				27.5	6.6	4.0	9.10	NA	22.20
18.67	530-F				41.0	11.0	6.7	NA	17.30	NA
18.74	530-F	90.4		78.0	38.3	10.0	6.1	NA	16.70	NA
18.03	ASTAR	95.0			25.1	6.0	3.6	6.60	22.40	27.40
18.68	ASTAR	94.8			27.2	6.5	4.0	NA	25.90	NA
18.56	ASTAR	91.6			26.5	6.4	3.8	1.60	19.70	NA
19.04	ASTAR	90.4	87.9		24.9	5.9	3.6	4.30	19.00	NA
18.06	ASTAR	89.1	88.4		35.4	9.0	5.5	0.80	NA	8.80
18.62	B-206L3	94.1			20.9	4.9	2.9	9.50	NA	NA
18.21	B-206L3	92.5			23.7	5.6	3.4	8.40	NA	16.80
18.69	B-206L3	92.5			26.2	6.3	3.8	NA	14.10	NA
18.64	B-214	98.6	91.0		24.9	5.9	3.6	11.40	24.50	NA
18.44	B-214		91.0		27.9	6.7	4.1	8.70	24.50	NA
17.18	B-222UT	95.6	90.9		26.6	6.4	3.9	7.40	NA	19.90
18.52	B-222UT	95.4	87.9		24.2	5.7	3.5	8.20	NA	NA
17.09	B-222UT	94.0			26.6	6.4	3.9	6.40	21.00	24.00
19.09	B-222UT	91.6			34.0	8.6	5.2	8.20	17.60	NA
18.53	B-412	100.9	91.4	75.1	22.1	5.2	3.1	12.70	26.20	35.00
19.21	B-412	97.8	90.0		26.4	6.3	3.8	10.30	25.30	NA
18.08	B-412				42.2	11.5	7.0	5.60	15.80	NA
18.16	B-412		89.9	81.4	41.7	11.3	6.9	6.10	15.20	16.20
18.45	Dauphin	100.4	95.6		28.0	6.8	4.1	6.10	23.20	27.20
18.54	Dauphin	99.5	93.5		30.0	7.4	4.5	6.60	26.10	29.60
18.35	Dauphin	96.0	90.5		21.5	5.0	3.0	8.30	26.60	28.60
18.01	Dauphin	97.5			26.8	6.4	3.9	5.50	19.60	24.60
18.31	Dauphin	92.3	93.5		29.6	7.2	4.4	2.50	23.00	NA

Table 2 (Continued)
HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS, JANUARY 17-20, 1985

Event Number	Helicopter	SEL (dBA) for Each Site			Elevation Angle for Each Site			Difference between Centerline & Sideline ALm in dB(A)		
		1	2	3	2	3	4	1-2	1-3	1-4
18.71	Dauphin	92.6			34.0	8.6	5.2	NA	15.80	23.30
18.49	Twin Star	95.3	91.0		29.1	7.1	4.3	5.70	18.50	26.50
17.08	Twin Star	94.6	92.5		31.9	.9	4.8	4.00	18.00	23.00
18.65	Twin Star				34.1	8.6	5.2	NA	24.50	24.00
18.24	Twin Star	94.1	93.0		30.4	7.5	4.5	0.70	16.50	20.50
19.03	Twin Star	92.2	90.2	77.8	27.3	6.6	4.0	1.90	17.70	NA
18.29	WG-30	104.6		81.1	25.1	6.0	3.6	10.40	26.70	27.40
18.73	WG-30			84.7	37.6	9.7	5.9	NA	9.00	17.60

Because of the variance in the helicopter altitudes during each pass the centerline ALm noise readings were adjusted to a reference altitude. The reference altitude (R_o) of 182 ft is the average altitude of all the valid centerline noise measurement events. The adjustment of ALm was based on the relation of 22 log(R/R_o) which approximates attenuation associated with spherical spreading and atmospheric absorption. There are other propagation factors which have not been accounted for, most notably source directivity, ground effects, and individual helicopter performance characteristics (i.e. RPM and power level). Table 3 is similar to Table 2, however, it provides statistical information for each helicopter measured. Also presented is the centerline ALm readings adjusted to the reference altitude (182 ft). The ALm values for the sideline sites were not adjusted since analysis of the sideline distances indicates that for distances of 1455 and 2410 ft from the centerline, the slant range distances did not change significantly between events.

In general, the data demonstrate that the noise level is fairly consistent between the various helicopter models and multiple flights of the same model. This is best shown by the standard deviation and 90% confidence level as presented in Table 3. The B-222UT showed the most consistent readings with an average ALm of 89.8 $\pm$ 1.23 dBA. The 500-E, which had the most recordings, showed a strong consistency between events with an average of 89.2 $\pm$1.86 dBA. The Dauphin and the WG-30, however, showed a greater spread in the data. Possible causes for this variation are numerous. Table 4 presents a summary of the standard deviations for each helicopter and the 90% confidence intervals for the centerline line center position. The average standard deviation for all the events is $\pm$2.05 dBA.

Table 3
STATISTICAL ANALYSIS OF HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS FOR SLANT RANGE, ALm, AND ADJUSTED ALm

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft) 2	3	4	ALm (dBA) for Each Site 1	2	3	4	Centerline ALm Adjusted to Reference Altitude
18 72	500-E	170	367	1465	2416	87 8	NA	66 0	57.0	87 1
18 63	500-E	134	352	1461	2414	88 6	74 7	NA	NA	85 7
18 36	500-E	269	422	1480	2425	84 6	76.6	NA	62 0	88 3
18 55	500-E	171	367	1465	2416	86 5	77 3	NA	NA	85 9
18 70	500-E	120	346	1460	2413	87.9	NA	60.0	57.0	83 9
18 66	500-E	185	374	1467	2417	86.0	NA	62.0	61 0	86 2
18 61	500-E	195	379	1468	2418	85 0	NA	NA	NA	85 7
18 27	500-E	96	339	1458	2412	87 4	75.0	61.0	62 0	81 3
19 08	500-E	240	404	1475	2422	83.0	75 7	NA	NA	85.6
18 58	500-E	184	373	1467	2417	83 4	73 8	63 5	NA	83.5
Average		176.40	372.32	1466.48	2416 95	86 02	NA	NA	NA	85.3
Number of Observations		10 00	10.00	10 00	10.00	10 00	NA	NA	NA	10 0
Standard Deviation		49.61	24.05	6.23	3.78	1.86	NA	NA	NA	1.9
90% Confidence Interval		25.81	12.51	3.24	1 97	0.97	NA	NA	NA	1.1
Maximum		269 00	421.88	1479 66	2424.97	88.60	NA	NA	NA	88.3
Minimum		96.00	338.88	1458 16	2411.91	83.00	NA	NA	NA	81.3
19 05	530-F	166	365	1464	2416	87.9	77.3	64.6	NA	87.0
18 23	530-F	159	362	1464	2415	87 1	77.5	NA	NA	85.8
18 46	530-F	141	354	1462	2414	87.3	76.2	NA	62.0	84.9
19 15	530-F	211	387	1470	2419	85.3	83.9	64.0	NA	86 7
18 67	530-F	283	431	1482	2427	83.3	NA	66 0	NA	87.5
18 74	530-F	257	414	1478	2424	83.0	NA	66.3	NA	86 3
18 11	530-F	169	366	1465	2416	84.2	75.1	NA	62.0	83 5
Average		198 00	382 87	1469.24	2418.63	85.44	NA	NA	NA	86.0
Number of Observations		7 00	7.00	7 00	7 00	7.00	NA	NA	NA	7.0
Standard Deviation		50 01	27 20	7 25	4.41	1.87	NA	NA	NA	1 3
90% Confidence Interval		31.10	16 91	4.51	2.74	1.16	NA	NA	NA	0.9
Maximum		283.00	430 95	1482 27	2426.56	87.90	NA	NA	NA	87 5
Minimum		141 00	354 27	1461.82	2414 12	83.00	NA	NA	NA	83.5
18 03	ASTAR	152	359	1463	2415	88 4	81.8	66 0	61 0	86 7
18 68	ASTAR	167	365	1465	2416	87.9	NA	62 0	NA	87 1
18 58	ASTAR	162	363	1464	2415	84 7	83 1	65 0	NA	83 6
19 04	ASTAR	151	358	1463	2415	84 0	79 7	65 0	NA	82 2
18 60	ASTAR	231	399	1473	2421	80 8	80 0	NA	72 0	83 1
Average		172 60	368 88	1465.50	2416 36	85 16	NA	NA	NA	84 5
Number of Observations		5 00	5 00	5 00	5 00	5 00	NA	NA	NA	5 0
Standard Deviation		29 82	15 16	3 92	2 38	2 78	NA	NA	NA	2 0
90% Confidence Interval		21 94	11 15	2 88	1 75	2.04	NA	NA	NA	1 9
Maximum		231 00	398 73	1473 22	2421 05	88 40	NA	NA	NA	87 1
Minimum		151 00	358 37	1462 81	2414 73	80 80	NA	NA	NA	82 2

Table 3
STATISTICAL ANALYSIS OF HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS FOR SLANT RANGE, ALm, AND ADJUSTED ALm

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft) 2	3	4	ALm (dBA) for Each Site 1	2	3	4	Centerline ALm Adjusted to Reference Altitude
18 62	B-206L3	124	348	1460	2413	87.9	78.4	NA	NA	84.2
18 21	B-206L3	143	355	1462	2414	84.8	76.4	NA	68.0	82.5
18 69	B-206L3	160	362	1464	2415	84.1	NA	70.0	NA	82.9
Average		142.33	355.06	1462.02	2414.24	85.60	NA	NA	NA	83.2
Number of Observations		3.00	3.00	3.00	3.00	3.00	NA	NA	NA	3.0
Standard Deviation		14.70	5.88	1.43	0.86	1.65	NA	NA	NA	0.7
90% Confidence Interval		13.97	5.58	1.36	0.82	1.57	NA	NA	NA	1.3
Maximum		160.00	362.25	1463.77	2415.31	87.90	NA	NA	NA	84.2
Minimum		124.00	347.85	1460.27	2413.19	84.10	NA	NA	NA	82.5
18 64	B-214	151	358	1463	2415	91.0	79.6	66.5	NA	89.2
18 44	B-214	172	368	1465	2416	88.5	79.8	64.0	NA	88.0
Average		NA	NA	NA	NA	NA	NA	NA	NA	NA
Number of Observations		NA	NA	NA	NA	NA	NA	NA	NA	NA
Standard Deviation		NA	NA	NA	NA	NA	NA	NA	NA	NA
90% Confidence Interval		NA	NA	NA	NA	NA	NA	NA	NA	NA
Maximum		NA	NA	NA	NA	NA	NA	NA	NA	NA
Minimum		NA	NA	NA	NA	NA	NA	NA	NA	NA
17 18	B-222UT	163	364	1464	2416	87.9	80.5	NA	68.0	86.8
17 09	B-222UT	163	364	1464	2416	87.0	80.6	66.0	63.0	85.9
18 52	B-222UT	146	356	1462	2414	87.1	78.9	NA	NA	85.0
19 09	B-222UT	219	392	1471	2420	84.6	76.4	67.0	NA	86.4
Average		172.75	368.84	1465.47	2416.34	86.65	79.10	NA	NA	86.0
Number of Observations		4.00	4.00	4.00	4.00	4.00	4.00	NA	NA	4.0
Standard Deviation		27.59	13.64	3.49	2.12	1.23	1.70	NA	NA	0.7
90% Confidence Interval		22.69	11.22	2.87	1.74	1.01	1.40	NA	NA	0.8
Maximum		219.00	391.90	1471.39	2419.93	87.90	80.60	NA	NA	86.8
Minimum		146.00	356.29	1462.31	2414.42	84.60	76.40	NA	NA	85.0

Table 3
STATISTICAL ANALYSIS OF HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS FOR SLANT RANGE, ALm, AND ADJUSTED ALm

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft) 2	3	4	ALm (dBA) for Each Site 1	2	3	4	Centerline ALm Adjusted to Reference Altitude
18.53	B-412	132	351	1461	2414	94.0	81.3	67.8	59.0	90.9
18.08	B-412	295	439	1485	2428	88.8	83.2	73.0	NA	93.4
19.21	B-412	161	363	1464	2415	90.3	80.0	65.0	NA	89.1
18.16	B-412	290	436	1484	2427	86.2	80.1	71.0	70.0	90.7
Average		219.50	396.99	1473.27	2421.09	89.83	81.15	69.20	NA	91.0
Number of Observations		4.00	4.00	4.00	4.00	4.00	4.00	4.00	NA	4.0
Standard Deviation		73.74	40.49	10.90	6.63	2.82	1.29	3.05	NA	1.5
90% Confidence Interval		60.65	33.30	8.96	5.45	2.32	1.06	2.51	NA	1.8
Maximum		295.00	438.92	1484.60	2427.99	94.00	83.20	73.00	NA	93.4
Minimum		132.00	350.78	1460.98	2413.61	86.20	80.00	65.00	NA	89.1
18.45	Dauphin	173	368	1465	2416	94.2	88.1	71.0	67.0	93.7
18.54	Dauphin	188	375	1467	2417	92.6	86.0	66.5	63.0	92.9
18.35	Dauphin	128	349	1461	2413	90.6	82.3	64.0	62.0	87.2
18.31	Dauphin	185	374	1467	2417	87.5	85.0	64.5	NA	87.7
18.01	Dauphin	164	364	1464	2416	87.6	82.1	68.0	63.0	86.6
18.71	Dauphin	219	392	1471	2420	86.3	NA	70.5	63.0	88.1
Average		176.17	370.47	1465.88	2416.59	89.80	NA	67.42	NA	89.4
Number of Observations		6.00	6.00	6.00	6.00	6.00	NA	6.00	NA	6.0
Standard Deviation		27.48	12.85	3.25	1.97	2.89	NA	2.70	NA	2.8
90% Confidence Interval		18.45	8.63	2.18	1.32	1.94	NA	1.81	NA	2.3
Maximum		219.00	391.90	1471.39	2419.93	94.20	NA	71.00	NA	93.7
Minimum		128.00	349.30	1460.62	2413.40	86.30	NA	64.00	NA	86.6
18.49	Twin Star	181	372	1466	2417	88.5	82.8	70.0	62.0	88.4
19.03	Twin Star	168	366	1465	2416	84.8	82.9	67.1	NA	84.0
17.08	Twin Star	202	383	1469	2418	87.0	83.0	69.0	64.0	88.0
18.65	Twin Star	220	392	1472	2420	86.0	NA	61.5	62.0	87.8
18.24	Twin Star	191	377	1467	2418	85.5	84.8	69.0	65.0	86.0
Average		192.40	377.99	1467.77	2417.73	86.36	NA	67.32	NA	86.9
Number of Observations		5.00	5.00	5.00	5.00	5.00	NA	5.00	NA	5.0
Standard Deviation		17.78	9.11	2.36	1.43	1.29	NA	3.06	NA	1.6
90% Confidence Interval		13.08	6.71	1.73	1.05	0.95	NA	2.25	NA	1.2
Maximum		220.00	392.46	1471.54	2420.02	88.50	NA	70.00	NA	88.4
Minimum		168.00	365.85	1464.67	2415.85	84.80	NA	61.50	NA	84.0

Table 3

STATISTICAL ANALYSIS OF HELICOPTER NOISE MEASUREMENTS FOR NEW ORLEANS FOR SLANT RANGE, ALm, AND ADJUSTED ALm

Event Number	Helicopter	Centerline Altitude (ft)	Slant Range for Noise Monitoring Stations (ft)			ALm (dBA) for Each Site				Centerline ALm Adjusted to Reference Altitude
			2	3	4	1	2	3	4	
18 29	WG-30	152	359	1463	2415	96 4	86.0	69.7	69 0	94 7
18 73	WG-30	250	410	1476	2423	85 6	NA	76 6	68 0	88 6
Average		NA	NA	NA	NA	NA	NA	NA	NA	NA
Number of Observations		NA	NA	NA	NA	NA	NA	NA	NA	NA
Standard Deviation		NA	NA	NA	NA	NA	NA	NA	NA	NA
90% Confidence Interval		NA	NA	NA	NA	NA	NA	NA	NA	NA
Maximum		NA	NA	NA	NA	NA	NA	NA	NA	NA
Minimum		NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4

Summary of the Standard Deviation
of Adjusted ALm and the 90% Confidence Interval by Helicopter
at the Centerline Center Location
(dBA)

Helicopter	Standard Deviation	90% Confidence Interval
500 E	1.9	1.1
530 F	1.3	0.9
AStar	2.0	1.9
B-206L3	0.7	1.3
B-222UT	0.7	0.8
B-412	1.5	1.8
Dauphin	2.8	2.3
Twin Star	1.6	1.2
Average	1.6	1.4

Table 5 presents the sideline ALm values as recorded, the slant range, and elevation angle for the sideline sites for only those events where there were valid ALm readings at all four monitoring sites. The small number of events demonstrates the difficulty in obtaining clear signals at four distant sites on a real time basis. There was very little variation in the slant ranges between helicopter events. The average elevation angle at Site 2 was 26.9°; Site 3, 6.6°; and Site 4, 4.0°. The ALm decreased significantly from the centerline values which reflects the distance and attenuation attributed to ground and atmospheric absorption. Figure 3 shows graphically the decrease in sideline ALm values between sites 2 and 4 for the 500E, ASTAR, B-222UT, B-412, Dauphin, Twin Star, and WG-30. The graphical presentations of sideline distances vs ALm readings are based on the average of all the readings available for each helicopter model. A second order regression of ALm vs slant range distance resulted in a correlation coefficient of 0.93. Closer scrutiny of the data indicates that for the 500-E the ALm reading at 2410 ft was 1 dBA greater than the value recorded at the closer-in site at 1455 ft. The increase of 1 dBA is not considered significant and can be possibly attributed to several factors such as directivity, ground reflection, attenuation, etc. Of greater importance is that the ALm values in all cases appear to approach the ambient noise levels for this area, since the helicopters were barely distinguishable at these distances. From a practical environmental standpoint, the noise associated with helicopter operations at a heliport would not significantly affect the ambient noise levels at 1500 ft or beyond in a suburban residential area.

Table 5

ALm VALUES FOR THOSE HELICOPTERS WHERE THERE WERE READINGS AT ALL THREE SIDELINE SITES

Event Number	Helicopter	Slant Range for Noise Monitoring Stations (ft) 2	3	4	ALm (dBA) for Each Site 2	3	4	Elevation Angle for Each Site (Degrees) 2	3	4
18.27	500-E	339	1458	2412	75.0	61.0	62.0	16.5	3.8	2.3
18.03	ASTAR	359	1463	2415	81.8	66.0	61.0	25.1	6.0	3.6
17.09	B-222UT	364	1464	2416	80.6	66.0	63.0	26.6	6.4	3.9
18.16	B-412	436	1484	2427	80.1	71.0	70.0	41.7	11.3	6.9
18.53	B-412	351	1461	2414	81.3	67.8	59.0	22.1	5.2	3.1
18.01	Dauphin	364	1464	2416	82.1	68.0	63.0	26.8	6.4	3.9
18.35	Dauphin	349	1461	2413	8[illegible] 3	64.0	62.0	21.5	5.0	3.0
18.54	Dauphin	375	1467	2417	[illegible].0	66.5	63.0	30.0	7.4	4.5
18.45	Dauphin	368	1465	2416	88.1	71.0	67.0	29.0	6.8	4.1
18.24	Twin Star	377	1467	2418	84.8	69.0	65.0	30.4	7.5	4.5
18.49	Twin Star	372	1466	2417	82.8	70.0	62.0	29.4	7.1	4.3
18.29	WG-30	359	1463	2415	86.0	69.7	69.0	25.1	6.0	3.6
	Number of Obs.	12	12	12	12.00	12.00	12.00	12.00	12.00	12.00
	Average	368	1465	2416	82.58	67.50	63.83	26.93	6.58	3.98
	standard dev	23.2	6.2	3.6	3.3	2.9	3.2	5.9	1.8	1.1
	90% Confid Int.	13.12	3.50	2.04	1.85	1.62	1.79	3.33	0.99	0.61

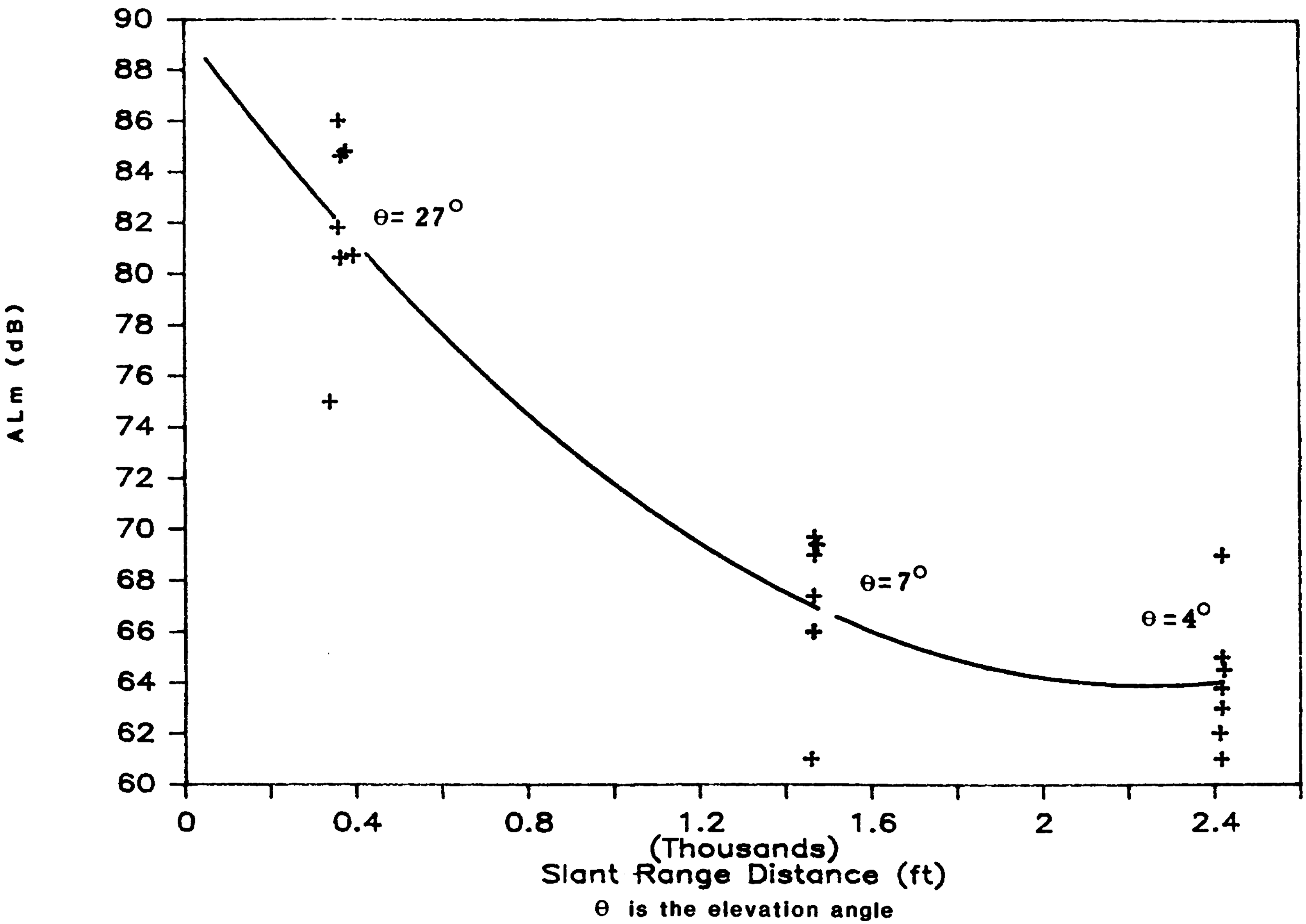

Figure 3 ALm vs Slant Range Distance

8.3 Community Noise

In addition to measuring the ALm and SEL values, a community noise analyzer was deployed during the monitoring program. Hourly readings during the test period indicated that the Leq value ranged from 58 to 60 dBA. These samples included on the average 20 helicopter operations including approaches, takeoff, and flybys at Lakefront. Figures 4 and 5 show the relation of helicopter noise and the existing ambient levels. It is clearly shown that at a distance of approximately 1500 ft. and beyond from the centerline microphone, the noise associated with the helicopter was barely above the ambient levels. Other sources of noise in the community showed ALm readings ranging from 58 to 66 dBA for cars and trucks and 72 dBA for buses. During the three day monitoring period when there was a high number of helicopter operations, there were no known noise complaints received at the airport due to the operations from the helicopters based at the airport for the the HAI Convention.

9.0 Summary

The FAA conducted a field noise monitoring program of helicopter operations at a busy general aviation airport. The purpose was to collect helicopter noise data as a continuing effort from the FAA to assess helicopter noise in different urban areas. The data collected emphasized landing approaches and indicated that there was a consistency between the noise levels measured for each helicopter model. The FAA had the opportunity to evaluate the potential impact of a high frequency of helicopter events in a residential community adjacent to a heliport.

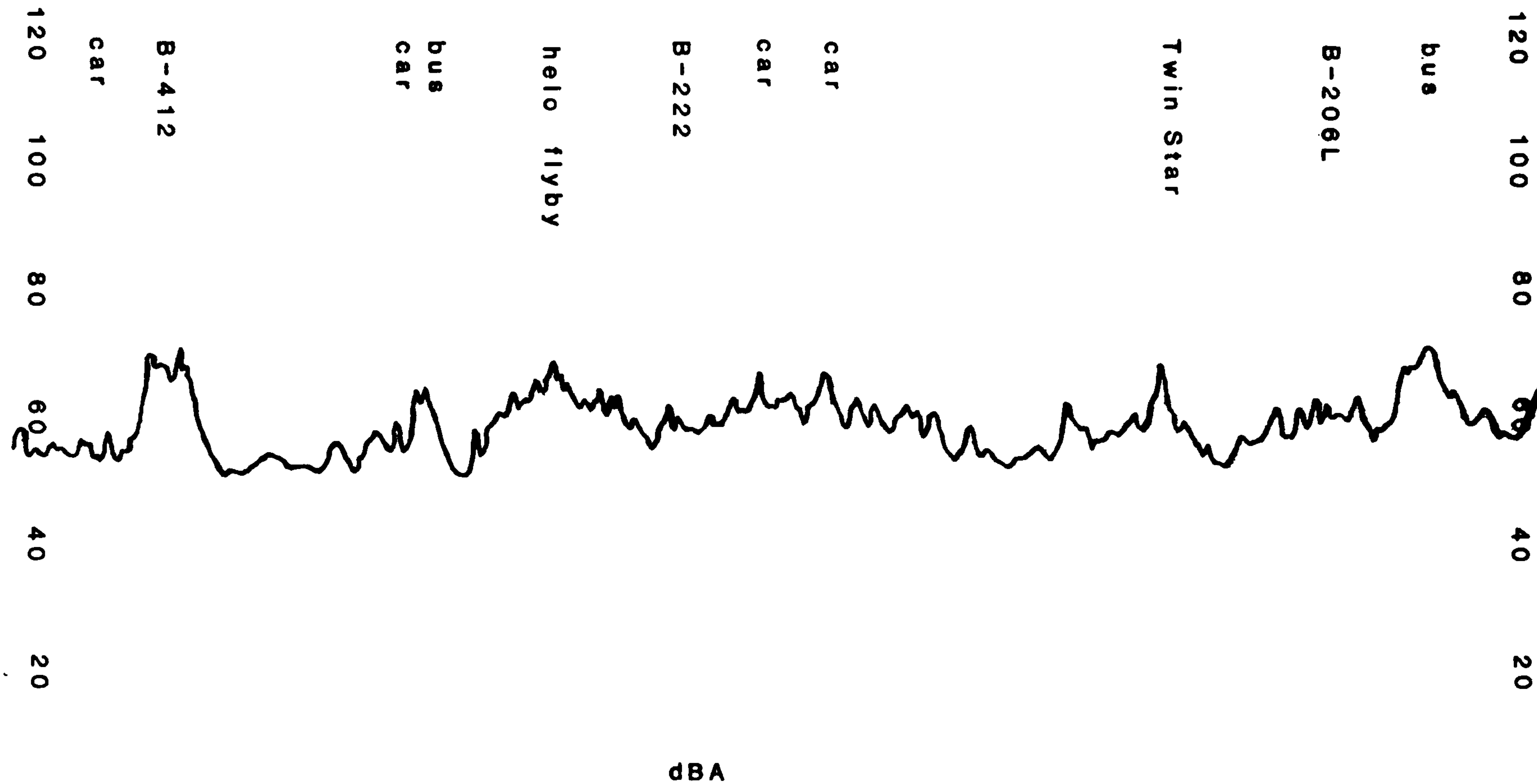

Figure 4 Time History of Selected Noise Events at Site 3

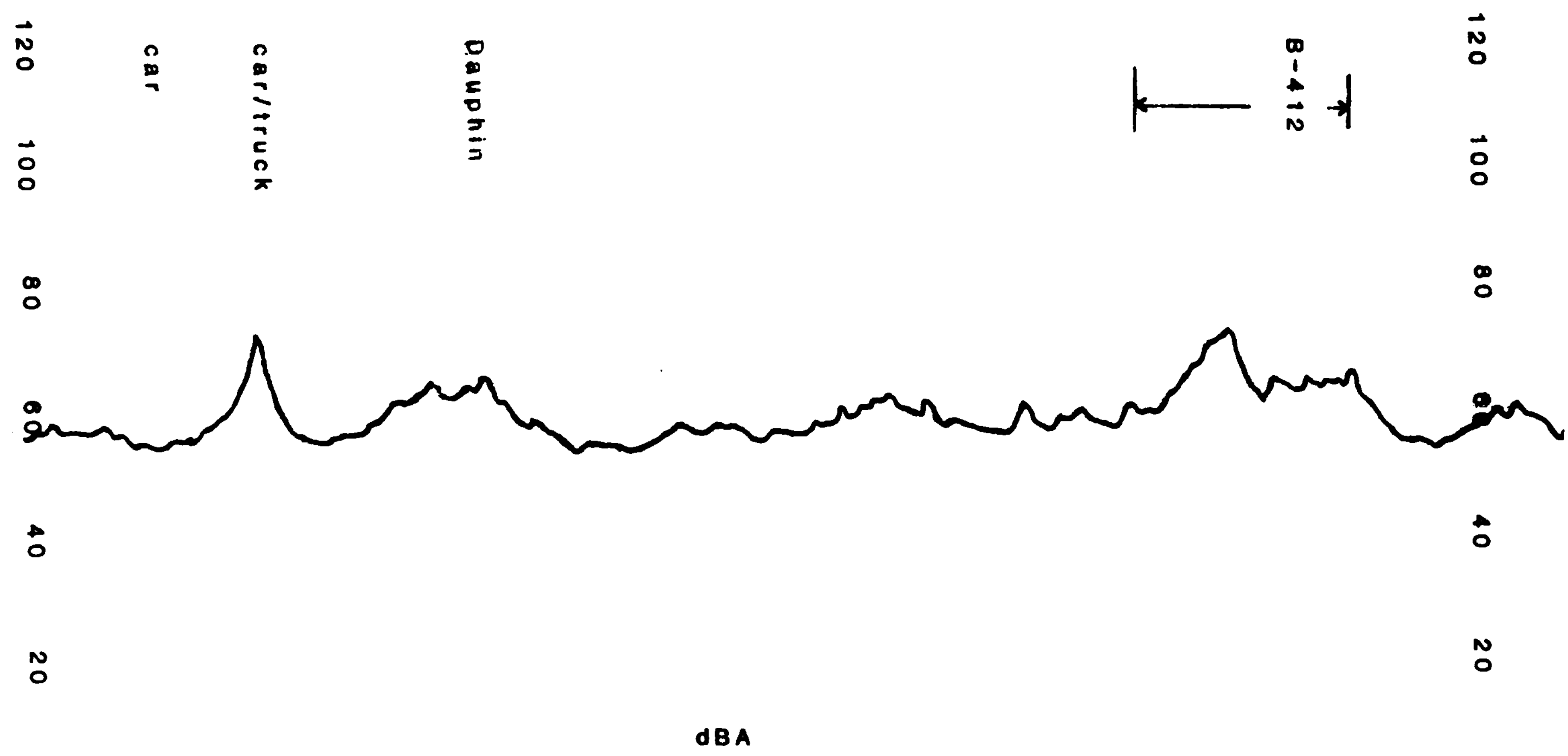

Figure 5 Time History of Selected Noise Events at Site 3

During the test period there were no known noise complaints received at the airport from the helicopter operations. In this case, the helicopters did not appear to impact significantly sites 1500 ft away. The lower data recovery, specifically SEL, at monitoring sites in the community reflects this fact. In most instances, this was due to the fact that the noise levels from the helicopters were barely distinguishable from the existing ambient noise levels at distances of 1500 ft and beyond.

Appendix A

Selected Specifications of Helicopter Types Monitored During the Test

Aerospatiale 355 F Twin Star

Power Plant	(2) Allison 250C-20F, 420 shp each
Main Rotor Diameter	35.1 ft
Tail Rotor Diameter	6.1 ft
Empty Weight	2840 lbs
Gross Weight	5071 lbs
Height	10.1 ft
Length	42.6 ft
Width	6.9 ft

Aerospatiale AStar

Power Plant	(1) Avo Lycoming LTS 101-600A2, 615 shp
Main Rotor Diameter	35.1 ft
Tail Rotor Diameter	6.1 ft
Empty Weight	2,432 lbs
Gross Weight	4,300 lbs
Height	10.3 ft
Length	42.6 ft
Width	6.9 ft

Aerospatiale Dauphin

Power Plant	(1) Turbomeca Astazou XVIII, 872 shp
Main Rotor Diamter	37.7 ft
Tail Rotor Diameter	3.0 ft
Empty Weight	2,900 lbs
Gross Weight	5,291 lbs
Height	10.2 ft
Length	42.6 ft
Width	6.9 ft

Bell 206L-III

Power Plant	(1) Allison 250-C30P, 650 shp
Main Rotor Diameter	37.0 ft
Tail Rotor Diameter	5.42 ft
Empty Weight	2,200 lbs
Gross Weight	4,150 lbs
Height	10.25 ft
Length	42.7 ft
Width	7.7 ft

Bell 222UT

Power Plant	(2) Lycoming LTS 101-750C, 684 shp each
Main Rotor Diameter	42 ft
Tail Rotor Diamter	6.88 ft
Empty Weight	4,874 lbs
Gross Weight	8,250 lbs
Height	10.42 ft
Length	50 ft
Width	10.25 ft

Bell 412

Power Plant	(2) P&W PT6T-3B, 900 shp
Main Rotor Diameter	46.0 ft
Tail Rotor Diameter	8.5 ft
Empty Weight	6,470 lbs
Gross Weight	11,900 lbs
Height	15.1 ft
Length	56.0 ft
Width	9.3 ft

Hughes 500E

Power Plant	(1) Allison 250-C20B, 420 shp
Main Rotor Diameter	26.35 ft
Tail Rotor Diameter	4.58 ft
Empty Weight	1,455 lbs
Gross Weight	3,000 lbs
Height	9.18 ft
Length	30.8 ft
Width	6.07 ft

Hughes 530F

Power Plant	(1) Allison 250-C30, 650 shp
Main Rotor Diameter	27.4 ft
Tail Rotor Diameter	4.75 ft
Empty Weight	1,585 lbs
Gross Weight	3,100 lbs
Height	9.18 ft
Length	32.06 ft
Width	6.07 ft

Westland WG-30

Power Plant	(2) GE CT7-2B, 1,615 shp
Main Rotor Diameter	43.67 ft
Tail Rotor Diameter	8.0 ft
Empty Weight	7,875 lbs
Gross Weight	12,800 lbs
Height	15.5 ft
Length	46.67 ft
Width	10.17 ft

ND

-9L